REMARKS

Applicants have amended their claims in order to further define various aspects of the present invention. Specifically, Applicants are adding new claims 33 and 34 to the application. Claim 33 expressly sets forth the subject matter recited in claim 9, but is dependent on claim 1. Claim 34, also dependent on claim 1, recites that the welding tool is pressed into the one of the members, while being rotated, so as to cause plastic flow mainly in a direction in which the welding tool rotates. Note, for example, the paragraph bridging pages 3 and 4 of Applicants' specification.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims in the Office Action mailed October 10, 2007, that is, the teachings of the U.S. patent documents to Iwashita, Patent Application Publication No. 2001/0038028, to Mahoney, Patent No. 6,543,670, to Waldron, et al., Patent No. 6,908,690, to Heideman, et al., Patent No. 6,053,391, and to Boon, et al., Patent No. 6,325,273, under the provisions of 35 USC 102 and 35 USC 103.

It is respectfully submitted that the teachings of the references as applied by the Examiner would have neither disclosed nor would have suggested such a friction stir welding method for a lap joint as in the present claims, wherein the welding tool used to cause friction stirring, to achieve the welding, has a small diameter projected part at a tip end of a shoulder, with the projected part and the shoulder being pressed into only one of the members, and not into a member, of the plurality of members, adjacent the one of the members, and with at least two of the plurality of members being of different metals from each other. See claim 1.

In addition, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a friction

stir welding method for a lap joint as in the present claims, using a welding tool pressed into one of the members, while being rotated, to cause friction stirring to achieve welding, the welding tool being pressed into only one of the plurality of members, which are made of different metal from each other, and wherein a tip end of the welding tool is flat and an outer peripheral surface thereof is rounded. See claim 10.

Furthermore, it is respectfully submitted that the applied references would have neither disclosed nor would have suggested such friction stir welding method as in the present claims, having features as discussed previously in connection with claims 1 and 10, and, additionally, wherein the method has further features as in the dependent claims in the application, including (but not limited to) wherein the small diameter projected part of the welding tool is semispherical in shape (see claim 2), and wherein a recess is provided on the shoulder (see claim 3); and/or wherein an outer peripheral surface of a tip end of the shoulder of the welding tool is inclined to define an inclined surface (see claim 4); and/or wherein an outer peripheral surface of a tip end of the shoulder of the welding tool is rounded (see claim 5); and/or wherein a welding boundary surface is activated and welded by plastic flow, with the pressing causing material of the one of the members to be discharged to an outer periphery of the welding tool (see claim 6); and/or wherein the welding interface is activated and welded by causing the one of the member to undergo plastic flows (see claims 12 and 33); and/or wherein spot welding is performed, as in claim 13; and/or wherein the lapped surfaces are coated with soft metal (see claim 15), in particular, any one of nickel, zinc and copper (see claim 16); and/or wherein the welding tool is moved in a direction of welding in a state in which the welding tool is pressed into only the one of the members (see claim 14); and/or wherein a trapezoidal member is provided on a surface of the one of the members on that side

into which the welding tool is pressed, as in claim 17; and/or wherein the welding tool does not extend through an entirety of the thickness of the one of the members, as in claims 28 and 29; and/or wherein the welding tool is pressed while being rotated, so as to remove surface oxide films on welding boundary surfaces of the one of the members and the member adjacent thereto (see claims 31 and 32); and/or wherein the welding tool is pressed while being rotated so as to cause plastic flow mainly in a direction in which the welding tool rotates (see claim 34).

The invention as presently claimed in the above-identified application is directed to a friction stir welding method, for providing a lap joint weld.

In welding a lap joint by means of friction stir welding, it is important to remove a surface oxide film on a lapped surface, to activate a boundary surface. Therefore, it is necessary to heighten pressure of plastic flow.

Applicants accomplish such objective, e.g., of removing the surface oxide film and forming a lap joint weld, according to the present invention, used in welding members of different metals from each other, utilizing a welding tool having a small diameter projected part at a tip of a shoulder, and pressing the projected part and the shoulder of the welding tool into the one of the members, the welding tool being pressed into only the one of the members and not into an adjacent member thereto. Through use of the welding tool as in the present invention, in the process of the present invention, plastic flow occurs toward both ends of the welding part in a state of high pressure and high temperature, and the plastic flow causes shearing stress on the welding boundary surface of the adjacent plates in the welding part, so that surface oxide films on the welding boundary surfaces are removed and both plates are mechanically welded. See the paragraph bridging pages 8 and 9 of Applicants' specification; note also page 5, lines 13-20 thereof.

As will be discussed in the following, it is respectfully submitted that the present invention is based on a different technical idea from that of the applied references, e.g., the present invention is based on removal of the surface oxide films for providing a good metallic weld, and that teachings of the applied references would have neither disclosed nor would have suggested the present invention.

Iwashita discloses a method for joining plate materials made of aluminum or pressed materials, as indicated in paragraph [0001] on page 1 of this patent document. The method includes moving frictional agitating means having a projection at an end portion thereof and rotating around an axis thereof to scattered joining portions, and joining the materials by pressing the projection on the joining portion. Note paragraph [0008] on page 1 of this document. See also paragraph [0032] on page 2 of Iwashita.

The Examiner has referenced Figs. 5 and 6, as well as paragraphs [0047]-[0050], of Iwashita, in the last paragraph on page 2 of the Office Action mailed October 10, 2007. It is described that in Fig. 5, first and second materials having different thickness can be joined, especially, pressing the rotary tool 1 from the thinner material side facilitates agitation to thereby achieve even joining. In connection with Fig. 6 and the description in paragraphs [0048]-[0050], and particularly paragraph [0049], it is disclosed that pressing the rotary tool 1 rotating at a predetermined speed of rotation substantially vertically on the first metal member W1 causes friction between the rotary tool 1 and the first material W1 to soften the surface of the first material W1 so that the metal texture between the first and second materials W1, W2 are agitated in the nonmelting condition in a rotational direction. As the pressing force against the first metal member W1 by the rotary tool 1 is increased, the second material W2 out of contact with the rotary tool 1 is started to be agitated together; and at this time, the metal texture of the first and

second materials W1, W2 are agitated in the rotational direction of the rotary tool 1 and also agitated in a direction of the thickness (in a direction perpendicular to the joining surface of the first and second materials W1 and W2) at the projection 2, and the superposed first and second materials W1 and W2 are finally joined without being melted.

Initially, it is noted that Figs. 5 and 6 are schematic drawings, with Fig. 5 focusing on relative thicknesses of members W1 and W2. Contrary to the conclusion by the Examiner, it is respectfully submitted that Iwashita does not disclose, nor would have suggested, pressing the projected part and the shoulder of the welding tool into one of the members and not into a member adjacent this one of the member. In this regard, it is emphasized that in Fig. 6 the shoulder rests on the surface of W1, and it is again emphasized that in connection with Fig. 5 the relative thicknesses of W1 and W2 are described. Thus, it is respectfully submitted that Iwashita would have neither disclosed nor would have suggested, either alone or in combination with the teachings of the other references as applied and as discussed infra, the presently claimed friction stir welding method for a lap joint, including wherein at least two of the plurality of members are of different metals from each other, the welding tool being pressed into only the one of the members, and not into an adjacent member, or the welding tool as in the present claims, and advantages thereof.

It is acknowledged that in paragraph [0049], reference is made to the second material W2 "out of contact with the rotary tool 1". However, this does not necessarily mean that in Iwashita the projected part of the welding tool is of necessity pressed into only the one of the members, and not into the adjacent member. For example, such projected part can be pressed into the adjacent member but not through an entire thickness thereof, whereby there would be second

material W2 “out of contact with the rotary tool 1”. Thus, it is respectfully submitted that Iwashita, either alone or in combination with the teachings of the other references discussed infra, would have neither disclosed nor would have suggested the present invention, including the technical idea of the present invention, e.g., removal of the surface oxide films for providing a good metallic weld, by the presently claimed method.

That is, it is emphasized that according to Iwashita, and particularly the embodiment of Fig. 6 thereof, the metal texture between the first and second materials are agitated, and the metal texture is also agitated in a direction of the thickness (in a direction perpendicular to the joining surface of the first and second materials W1 and W2). Clearly, according to Iwashita there is a mixing of materials of the first and second materials of the respective members, a different technical idea from that of the present invention. In this regard, it is respectfully submitted that the disclosure of Iwashita would have taught away from various features of the present invention, including, inter alia, wherein the welding interface is activated and welded by causing the one of the members to undergo plastic flow (note, e.g., claims 6 and 33; note also claim 12); and/or wherein the pressing of the welding tool is so as to remove surface oxide films on welding boundary surfaces of the one of the members and the member adjacent thereto (see claims 31 and 32); and/or wherein the welding tool is pressed while being rotated so as to cause plastic flow mainly in a direction in which the welding tool rotates (see claim 34).

It is respectfully submitted that the teachings of the secondary references would not have rectified the deficiencies of the teachings of Iwashita, such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Heideman, et al. discloses a friction stir welding tool having a specified pin profile for the friction stir weld tool tip. The tool comprises a cylinder and a distally projecting pin having a complex surface profile; and the pin is preferably a substantially cylindrical pin projecting from the distal shoulder surface and having a longitudinal axis co-extensive with the cylinder longitudinal axis. Note column 3, lines 30-41. This patent refers to an article by C. J. Dawes, et al., as discussing friction stir welding, and describing the added advantages thereof of welding dissimilar materials.

Mahoney discloses friction stir weld joints and a method of formation thereof. The method includes forming a friction stir weld joint between first and second workpieces such that the first and second workpieces define at least one interface notch therebetween, the interface notch being described at column 2, lines 5-9, in connection with Fig. 3, and being the portion of the workpiece interface adjacent the weld joint that is not consumed in the weld microstructure. Concurrently with the forming step, an interface layer positioned between the first and second workpieces is at least partially melted, the interface layer having a melting temperature lower than the solidus temperatures of the first and second workpieces, so that, as the first and second workpieces are plasticized by the probe and shoulder of the friction stir welding tool, the interface layer melts from the heat generating through the friction stir welding process. The melted portion of the interface layer is then allowed to cool; and, concurrently with the cooling step, the at least one interface notch is relocated away from the weld joint to thereby reduce the stress concentration adjacent the weld joint. Note column 2, lines 19-38. This patent also describes, in connection with the background of the invention therein, that the mixing action occurring in friction stir welding is particularly advantageous when welding workpieces formed of different materials. Note column 1, lines 24 and 25.

Compare this mixing action described in Mahoney, with the technical idea of the present invention of activating the welding interface by removal of the oxide, as discussed previously.

Waldron, et al. discloses backing up a weld joint during friction stir welding, including a tool for forming a friction stir weld joint. The tool includes a rotatable pin having first and second ends and defining a stirring portion there between structured to frictionally engage the workpiece so as to at least partially form the friction stir weld joint, the tool including a rotatable first shoulder defining an aperture therethrough structured to slidably receive the first end of the pin, and the tool also including a second shoulder defining an aperture structured to receive the second end of the pin such that the pin extends between the first and second shoulders and such that the second shoulder is in rotatable communication with the pin. See column 2, lines 30-42. Note also column 2, lines 49-53; and column 4, lines 7-22. Note that according to Waldron, et al., the tool extends through the entire structure being joined. As applied by the Examiner, Waldron, et al. discloses using the welding tool described therein with the structural members comprising different materials. Note column 5, lines 13-28.

Noting that, as applied by the Examiner, Iwashita discloses structure wherein the rotary tool does not extend through all members being joined, it is respectfully submitted that one of ordinary skill in the art concerned with in Iwashita would not have looked to the teachings of Waldron, et al., having the intermediate pin with first and second shoulders.

In any event, it is respectfully submitted that the combined teachings of Iwashita and the secondary references as applied by the Examiner in the rejection on pages 2-5 of the Office Action mailed October 10, 2007, would have neither disclosed nor would have suggested the presently claimed invention, including, inter

alia, wherein the welding tool is pressed into only the one of the members and not into an adjacent member, in using a welding tool having the structure recited in the present claims, with the projected part and the shoulder being pressed into the one of the members, in performing friction stir welding for a lap joint of members of different metals from each other, and advantages achieved due thereto.

Moreover, and noting particularly aspects of the present invention reciting activation of the welding interface and the achieved welding, e.g., by plastic flow, as in various of the present claims, it is respectfully submitted that the combined teachings of Iwashita with any one of Mahoney, Waldron, et al. and Heideman, et al., would have taught away from aspects of the present invention.

In connection with claims 4 and 5, Boon, et al. discloses a mobile friction welding machine and method of friction welding suitable for joining workpieces and forming a joint region therebetween. The method includes offering a probe of material harder than the workpiece material to the workpiece material surfaces in the joint region, a head region of the probe contacting one or more workpieces; causing a rotational movement between the probe and the workpieces while urging the probe and workpieces together whereby frictional heat is generated in the joint region so as to create a plasticized region in the workpieces around the probe; and removing the probe or advancing the probe along the joint region and allowing the plasticized region to solidify and thereby join the workpieces together, this patent disclosing that the head region of the probe incorporates a plurality of protrusions adapted to penetrate the workpieces. This patent goes onto disclose that when the workpieces are joined by a lap joint the protrusions are so sized and shaped that they fully penetrate the workpiece nearest the probe but only partially penetrate the other workpiece. Note column 3, lines 6-32. This patent goes on to disclose that

preferably the probe is slightly displaced, in use, from the plane perpendicular to the workpieces. See column 3, lines 61-65.

It is emphasized that Boon, et al. discloses that the protrusions of the tool fully penetrate the workpiece nearest the tool but only partially penetrate the other workpiece. Compare with the present invention, reciting that the welding tool is pressed into only the one of the members, and not into an adjacent member. Taking the teachings of Boon, et al. as a whole, in combination with the teachings of the other applied references, such combined disclosures would have taught away from the present invention, including extent of penetration of the welding tool.

In addition, it is respectfully submitted that the combined teachings of references as set forth in the first full paragraph on page 5 of the Office Action mailed October 10, 2007, would have neither taught nor would have suggested the other features of the present invention as discussed previously, including, e.g., activation of the welding interface.

In connection with the subject matter of claims 10, 12, 15-17, 27 and 30, it is respectfully submitted that the combined teachings of Iwashita and of Mahoney would have neither disclosed nor would have suggested the present invention, including features of these claims as discussed previously.

The contention by the Examiner that Mahoney teaches a tip end of the welding tool is flat and an outer peripheral surface thereof is rounded, the Examiner referring to Figs. 3 and 5 thereof in connection therewith, is noted. It is respectfully submitted that the figures of Mahoney are in essence schematic; and it is respectfully submitted that this reference does not disclose, nor would have suggested, the profile of the welding tool as in claim 10, with location of the welding tool in causing the friction stir to achieve welding; and, more particularly, the

technical feature of the present invention of activating the weld interface and welding by causing the one of the members to undergo plastic flow.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including any extension of time fees, to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case No. 500.45682X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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